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Higher Perceived Stress Scale scores are associated with higher pain intensity and pain interference levels in Older Adults

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Abstract

Objectives—To determine the prevalence of bodily pain measures (pain intensity and pain interference) in elderly people and their relationship with perceived stress scale (PSS) scores.

Design—Cross-sectional.

Setting—Community.

Participants—A representative community sample of 578 subjects aged 70 and older.

Measurements—The prevalence of pain intensity and pain interference and their relationship with perceived stress scale scores, demographic factors, past medical history, and neuropsychological testing scores were examined. Pain intensity and pain interference were measured by the SF-36 bodily pain questions.

Results—The study sample of 578 participants has a mean age of 78.8 years and is 63% female. Bivariate analysis for pain measures showed that higher scores on the perceived stress scale, lower neuropsychological test scores, and medical histories were associated with both pain intensity and interference. Logistic regression showed that higher scores on the perceived stress scale were significantly associated with increased odds of having moderate/severe pain intensity and moderate/severe pain interference (with and without the inclusion of for pain intensity in the models).

Conclusion—Higher PSS scores are associated with higher levels of pain intensity and pain interference. In this cross-sectional analysis, directionality cannot be determined. As both perceived stress and pain are potentially modifiable risk factors for cognitive decline and other poor health outcomes, future research should address temporality and the benefits of treatment.

Keywords

chronic pain; pain intensity; pain interference; elderly

INTRODUCTION

The Institute of Medicine classifies chronic pain as a public health problem that affects 100 million adults with an annual economic cost ranging between $560–$635 billion[1]. Where applicable, research should identify potentially modifiable risk factors and stakeholders should enact approaches aimed at pain prevention, treatment, and care[1].

Cognitive, psychological, and behavioral factors influence the pain experience[2–4]. Chronic pain is associated with psychopathology, including psychiatric and psychological disorders[2]. Psychological factors are important in the coping, quality of life, and disability experienced in chronic pain sufferers[4]. Research has identified an association between perceived stress and various pain syndromes; including recurrent, orofacial, and arthritis related pain[5–7]. The perceived stress scale (PSS) is a psychosocial measurement of an individual's appraisal of life events as stressful[8–10]. It focuses on the subjective experience and how life is unpredictable, uncontrollable, and overloading. The PSS is correlated with life event scores, but is considered a more accurate reflection of stress experienced. Objective stress scales count number of stressful events, ignoring personal and contextual factors. In comparison, the PSS measures a cognitively mediated emotional response to an objective event incorporating an individual's social support system, robustness, and locus of control[8–10].

The relationship between perceived stress and bodily pain has not been studied, particularly in an elderly community based population. There is a paucity of epidemiologic research focused on temporally concurrent perceived stress and its association with pain measures. Concurrent analysis is important, because perceived stress is variable over time and changes in response to an individual's current daily hassles, major life events, and present coping ability[9].

Herein, we examined the association of perceived stress with bodily pain measures in the elderly over a 4-week period using cohort data from the Einstein Aging Study (EAS). Our pain outcomes included pain intensity (severity) and pain interference (pain related disability). We hypothesized that higher levels of perceived stress would be associated with increased levels of both measures.

METHODS

Study Population

Participants in this study were sampled from the EAS, a methodically-recruited, population-based longitudinal study of adults age 70 and older who reside in Bronx County, New York. Study design, enrollment procedures, and methods have been previously described[11]. Katz et al. has demonstrated that the EAS is representative of the Bronx English speaking elderly community by age, gender, and education[11]. Participants were recruited using voter registration lists and Medicare eligibility information. Exclusion criteria included non-English speaking, severe audiovisual disturbances, prevalent dementia, institutionalization, or any condition that would interfere with participation (active psychiatric symptoms). Written informed consent was obtained during clinic visits in accordance with study protocols approved by the Institutional Review Board of the Albert Einstein College of Medicine.

Clinical Evaluation

Participants were evaluated by demographic surveys, structured medical history form, and queries concerning personal events. The entirety of our study sample was dementia free as

ascertained at case conferences with neuropsychology and neurology input using standardized clinical criteria from the DSM-IV[12].

We focused on medical conditions with the highest prevalence in our study population; including diabetes, congestive heart failure, hypertension, angina, myocardial infarction, stroke, chronic obstructive lung disease, and osteoarthritis. Lifestyle variables, alcohol consumption and smoking history were included because of their impact on pain. Alcohol consumption over the past year (in grams) was categorized into tertiles; the lowest tertile serving as reference. Smoking history was categorized as never, former, and current smoker.

Neuropsychological Evaluation

Prior literature has shown an inverse relationship between neuropsychological function and pain measures, necessitating inclusion to control for possible confounding. The Reading Subtest grade equivalency score from the Wide Range Achievement Test (WRAT3)[13] has a continuous range from 1–13. The Wechsler Adult Intelligence Scale - Third Edition[14] Verbal IQ (VIQ) score reflects performance on language-based tests of comprehension and problem solving. Free Recall (0–48) is a measure of episodic memory from the Free and Cued Selective Reminding Test[15]. Phonemic fluency[16] (“FAS”; number of correctly named words) and a test of set shifting and concept formation (Trail Making Test Part B[17]; seconds to test completion) measured executive functioning. Depressive symptoms were evaluated using the 15- item Geriatric Depression Scale (GDS); a score of >5 was defined as positive[18].

Stress Evaluation

The PSS is a global assessment of an individual’s perception of psychological stress during the past month[9]; the original scale consisted of 14-items. PSS was included in the EAS testing battery in 2006. Prior factor analysis performed in this cohort identified a two factor solution[19], consistent with published literature; item 12 did not load strongly on either factor, and was not included in the analysis. Our modified measure PSS-13 had reliable factor structure and predictive validity in our population sample[19]. Our scale contained six negatively worded items (questions 1, 2, 3, 8, 11, and 14), and seven positively worded items (questions 4, 5, 6, 7, 9, 10, and 12). Each item was rated on a five point scale. Scores were calculated after reverse keying positive items and summation of scores. Possible total scores range from 0–52 (higher score indicates greater stress; however, this effect is non-linear). The PSS is not a diagnostic instrument and no predetermined cut-points qualify different levels of perceived stress. For our analysis, PSS was modeled two ways: 1) divided into equally weighted quartiles with the first quartile (lowest levels of stress) serving as the reference group and 2) as a continuous variable.

Pain Evaluation

Bodily pain measures were drawn from the Short Form 36[20]. Pain intensity was questioned as, “How much bodily pain have you had during the past 4 weeks?” Responses range from 1 to 6 with 1 = “None” and 6 = “Very Severe.” Participants were dichotomized into two groups: no/mild pain intensity vs. moderate/severe pain intensity. Pain interference was questioned as, “During the past 4 weeks, how much did pain interfere with your normal

work (including both work outside the home and housework)?" Responses range from 1 to 5 with 1 = "Not at all" and 5 = "extremely." Participants were dichotomized into two groups: no/mild pain interference vs. moderate/severe pain interference. These methods of surveying and categorizing bodily pain outcomes have previously been used in population-based studies[21, 22].

Statistical Analysis

Analyses were performed using STATA software, version 12.1 (College Station, Texas). Characteristics were compared separately for the dichotomous outcome variables pain intensity and pain interference and the independent variables describing the participant's demographic and medical history. Continuous variables were compared using two-sample t-tests, or, when the variables had a distribution far from normal, by Mann-Whitney Wilcoxon tests. Categorical variables were compared using the Pearson chi-square test or Fisher's exact test.

To examine the effect of PSS on pain status we fit logistic regression models to our data. We developed separate models for pain intensity (no/mild pain intensity vs. moderate/severe pain intensity) and for pain interference (no/mild pain interference vs. moderate/severe pain interference) with and without inclusion of pain intensity in the models. In an effort to take into account potential confounders we included in our models variables with bivariate baseline testing results of $p < 0.25$; or variables, such as age, race, and gender, that were selected a priori. This was repeated with PSS as a categorized and continuous variable. We assigned statistical significance at an alpha level of 0.05. Elevated odds ratios indicate the increased likelihood of pain intensity or pain interference. The odds ratio for continuous variables such as age represents the change in odds for each additional unit change. Model assumptions of normality and linearity were assessed both graphically and statistically; goodness of fit testing was performed.

RESULTS

Between February 2006 and February 2012 a total of 806 individuals were evaluated for inclusion in the EAS with 19 individuals excluded for prevalent dementia at baseline. 787 dementia free individuals were considered for the current analysis. 578 individuals had available pain and stress data from the same 4 week period and were included in the present analysis; 403 individuals had complete covariate data, allowing for inclusion in logistic regression models.

Results of bivariate analysis show that both moderate/severe pain intensity (Table 1) and moderate/severe pain interference (Table 2) were associated with higher levels of perceived stress. Logistic regression showed that higher levels of perceived stress was associated with increased odds of having both bodily pain measures, moderate/severe pain intensity (OR=1.05 per unit increase in PSS score, Table 3) and moderate/severe pain interference (OR=1.07 per unit increase in PSS score, Web-Table 2). As compared to the 1st quartile (lowest levels of stress), the 2nd (OR=2.12), 3rd (OR=2.47), and 4th (OR=3.47) quartiles of PSS scores had increased odds of moderate/severe pain intensity, respectively (Table 3). As compared to the 1st quartile, the 2nd (OR=5.13), 3rd (OR=5.87), and 4th (OR=7.32) quartiles

of PSS scores had increased odds of moderate/severe pain interference, respectively (showing results for models with pain intensity included as a predictor, Web-Table 2. Similar results obtained in models without pain intensity included as a predictor, Web-Table 1).

Logistic regression analysis also revealed the following significant associations for the bodily pain measures. Increased odds of having moderate/severe pain intensity were associated with congestive heart failure and osteoarthritis; increased age was associated with decreased odds of having moderate/severe pain intensity (Table 3). Increased odds of having moderate/severe pain interference was associated with moderate/severe pain intensity, being non-Caucasian/non-African American race, having depressive symptoms, and osteoarthritis; increased age, higher free recall scores, and higher consumption of alcohol were associated with decreased odds of having moderate/severe pain interference (Web-Table 1 and Web-Table 2).

DISCUSSION

We have shown that higher levels of perceived stress were associated with both higher levels of pain intensity and pain interference in an elderly population of dementia-free individuals. This association remained significant when age, gender, race, medical history, depressive symptoms and neuropsychological test performance were included as covariates in the models; and when modeled as continuous or categorical variables, pointing to the robustness of our findings. Our research focuses on a community based sample of older adults; prior research was focused on pediatric and middle aged populations and examined specific pain syndromes[5–7]. This is the first study to our knowledge to examine the association between perceived stress and bodily pain measures.

The relationship between increased psychological distress and chronic pain[2–4] is often referred to as the diathesis-stress model of pain[23, 24]. Chronic stress leads to dysregulation in the body's "supersystem" (comprised of the nervous, endocrine, and immune systems) that regulate an individual's experience of pain[23]. The excess psychosocial distress increases the allostatic load placed on the body resulting in chronic disorders, including pain[23, 24]. Increased perceived stress has been associated with a broad array of adverse health outcomes[25, 26.] Based on our results, the diathesis or vulnerability would be higher levels of perceived stress experienced by the individual. This present study, however, did not examine other psychological constructs that are related to pain, limiting our ability to identify mediators or confounders in the perceived stress and pain pathways. A limitation of this study is that it is cross-sectional. Therefore, temporal sequences describing pain and stress cannot be established. Future research should explore longitudinal analysis to better explore these relationships.

Our model results show that higher scores on the perceived stress scale were associated with an increase in both pain intensity and pain interference (and remained significant when pain intensity level was included as a model predictor). We suggest that perceived stress may influence pain interference directly and through a pathway mediated by pain intensity.

Most likely a bidirectional relationship exists where pain exacerbates stress and stress exacerbates pain. Methods that reduce both may improve the adverse health outcomes linked to these common symptoms in late life. Research has linked the presence of high stress and chronic pain together as a risk factor for shortened telomere length and advanced cellular aging[27]; which is associated with negative health outcomes including cardiovascular disease, cognitive function, and immune function, among others. Presence of both frequent musculoskeletal pain and perceived stress are risk factors for reduced work performance and ability[28]. Therefore, methods to reduce stress should be employed and further explored. These include meditation, physical exercises, and coping strategies[29, 30].

This study has several limitations. We utilized data from a sample of elderly participants, age 70 years and above, who reside in Bronx, New York; questions about external validity exist and whether our results can be applied to other samples. Studies have shown that the prevalence of pain interference rises sharply with increasing age[22]; the prevalence of chronic pain increases until around age 65, followed by a plateau, and a decrease in reported pain for ages 75 and older[21]. Prevalence of medical histories in the EAS was previously found to be similar to rates for persons over age 65 in the US[11].

The EAS does not have sufficient data on participant's anxiety, pain self-efficacy, pain coping, and pain acceptance. Future research should reexamine our findings in light of these other psychological constructs. Some pain associated disease states such as fibromyalgia were excluded from our analysis because of insufficient data. We relied on self-reported data. Recall bias is a possibility, although this would tend to be non-differential and would attenuate our results towards the null hypothesis. The bodily pain measures reflect a four week prevalence of pain and may not be representative of experienced pain for longer time periods. These pain measures were used in prior studies[21, 22] and we believe they are indeed representative of the pain experience. Lack thereof appropriate representation would most likely be non-differential and would serve to attenuate our findings toward the null hypothesis.

In light of the economic recession (2008–2009) and increase in perceived stress due to nationwide financial and occupational uncertainties, one potential limitation of our study was the use of PSS data ranging from 2006 to 2012. Cohen at al. examined this question and reported that the associated increase in perceived stress did not affect individuals aged 65 and older[8], representative of our study population.

Our study has a number of strengths. Our sample was drawn from the EAS, a large ethnically diverse population-based study. The EAS uses well established procedures to ascertain demographic information, medical history, and neuropsychological scores. Our measures for pain[21, 22] and perceived stress[4, 9, 10] have been previously studied and shown to be psychometrically accurate and reliable. These measures were temporally balanced during the same 4-week time period allowing for concurrent associations between perceived stress and pain to be calculated. The models used in our study included all covariates with bivariate testing <0.25 and we believe that our findings for perceived stress are conservative estimates.

The present study has shown that persons with higher levels of perceived stress have increased reporting of pain intensity and pain interference. Caution must be used in interpreting our results since they show only associations and do not show causality. Future research should focus on interventional trials to determine if stress reducing techniques lead to a reduction in pain measures.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1

Demographic and medical characteristics of subjects by presence of pain intensity

Variables	Total (n=578)	No/mild Pain Intensity (n=384) 66.4%	Moderate/Severe Pain Intensity (n=194) 33.6%	p-value
Demographics				
Age Mean (± SD)	78.8 (5.4)	78.9 (5.6)	78.5 (5.1)	0.44
Female, N (%)	367 (63.5)	217 (56.5)	150 (77.3)	<0.001
Race - African American, N (%)	168 (29.1)	102 (26.6)	66 (34.0)	0.11
Race - Other, N (%)	48 (8.3)	30 (7.8)	18 (9.3)	
Lifestyle, N (%)				
Non-smoker	244 (44.4)	162 (44.0)	82 (45.3)	
Former smoker	279 (50.8)	190 (51.6)	89 (49.2)	0.76
Current Smoker	26 (4.7)	16 (4.4)	10 (5.5)	
Alcohol – 1st tertile	158 (28.7)	96 (26.0)	62 (34.3)	0.008
Alcohol – 2nd tertile	181 (32.9)	115 (31.2)	66 (36.5)	
Alcohol – 3rd tertile	211 (38.4)	158 (42.8)	53 (29.3)	
Perceived Stress				
PSS Mean (S.D.)	16.4 (7.7)	15.6 (7.8)	17.9 (7.2)	<0.001
1st Quartile (PSS scores 0–11), N (%)	163 (28.2)	124 (32.3)	39 (20.1)	
2nd Quartile (PSS scores 12– 16), N (%)	145 (25.1)	97 (25.3)	48 (24.7)	0.003
3rd Quartile (PSS scores 17–22), N (%)	153 (26.5)	64 (16.7)	53 (27.3)	
4th Quartile (PSS scores 23–50), N (%)	117 (20.2)	64 (16.7)	53 (27.3)	
Psychological Testing				
Depressive symptoms	64 (11.1)	33 (8.6)	31 (16.0)	0.008
WRAT3 Mean (± SD)	12.04 (2.1)	12.10 (2.0)	11.93 (2.2)	0.34
Free Recall Mean (± SD)	30.5 (6.7)	30.5 (6.9)	30.6 (6.2)	0.87
VIQ Mean (± SD)	109.2 (16.4)	110.6 (16.5)	106.4 (15.8)	0.012
FAS Mean (± SD)	35.6 (12.9)	35.9 (13.0)	34.9 (12.6)	0.38
Trails B Mean (± SD)	142.3 (73.1)	141.4 (73.7)	144.1 (72.2)	0.67
History of Medical Illnesses, N (%)				
Hypertension	374 (64.7)	238 (62.0)	136 (70.1)	0.054
Myocardial infarction	39 (6.8)	23 (6.0)	16 (8.3)	0.31
Stroke	44 (7.6)	28 (7.3)	16 (8.3)	0.68
Diabetes	115 (19.9)	68 (17.7)	47 (24.2)	0.064
Angina	32 (5.5)	18 (4.6)	14 (7.2)	0.21
Osteoarthritis	377 (65.2)	220 (57.3)	157 (80.9)	<0.001
COPD	44 (7.6)	19 (5.0)	25 (12.9)	0.001
Congestive Heart Failure	22 (3.8)	11 (2.9)	11 (5.7)	0.096

Note: All data presented in mean (standard deviation), unless otherwise specified. Continuous variables analyzed by ANOVA; categorical variables analyzed by Pearson chi-square test or Fisher's exact test. P-values refer to comparisons between pain intensity levels. PSS: perceived stress scale. Depressive symptoms were evaluated using the 15- item Geriatric Depression Scale. VIQ: verbal IQ. COPD: Chronic Obstructive Pulmonary Disease. WRAT3 is measured by the Wide Range Achievement Test. Free Recall is measured by the Free and Cued Selective Reminding Test. Verbal IQ score is a summary measure drawn from the Wechsler Adult Intelligence Scale - Third Edition.

Table 2

Demographic and medical characteristics of subjects by presence of pain interference

Variables	Total (n=578)	No/mild Pain Interference (n=481) 83.2%	Moderate/Severe Pain Interference (n=97) 16.8%	p-value
Demographics				
Age Mean (± SD)	78.8 (5.4)	78.9 (5.5)	78.4 (5.4)	0.48
Female, N (%)	367 (63.5)	301 (62.6)	66 (68.0)	0.31
Race - African American, N (%)	168 (29.1)	137 (28.5)	31 (32.0)	0.17
Race - Other, N (%)	48 (8.3)	36 (7.5)	12 (12.4)	
Lifestyle, N (%)				
Non-smoker	244 (44.4)	205 (44.9)	39 (42.4)	
Former smoker	279 (50.8)	230 (50.3)	49 (53.3)	0.87
Current Smoker	26 (4.7)	22 (4.8)	4 (4.4)	
Alcohol – 1st tertile	158 (28.7)	125 (27.2)	33 (36.3)	0.032
Alcohol – 2nd tertile	181 (32.9)	147 (32.0)	34 (37.4)	
Alcohol – 3rd tertile	211 (38.4)	187 (40.7)	24 (26.4)	
Perceived Stress				
PSS Mean (± SD)	16.4 (7.7)	15.7 (7.6)	19.4 (7.3)	<0.001
1st Quartile (PSS scores 0–11), N (%)	163 (28.2)	152 (31.6)	11 (11.3)	
2nd Quartile (PSS scores 12–16), N (%)	145 (25.1)	120 (25.0)	25 (25.8)	<0.001
3rd Quartile (PSS scores 17–22), N (%)	153 (26.5)	125 (26.0)	28 (28.9)	
4th Quartile (PSS scores 23–50), N (%)	117 (20.2)	84 (17.5)	33 (34.0)	
Psychological Testing				
Depressive Symptoms	64 (11.1)	40 (8.3)	24 (24.7)	<0.001
WRAT3 Mean (± SD)	12.04 (2.1)	12.13 (2.0)	11.62 (2.4)	0.027
Free Recall Mean (± SD)	30.5 (6.7)	30.7 (6.7)	29.5 (6.3)	0.11
VIQ Mean (± SD)	109.2 (16.4)	110.0 (16.3)	105.5 (16.5)	0.032
FAS Mean (± SD)	35.6 (12.9)	35.7 (12.5)	34.8 (1.5)	0.57
Trails B Mean (± SD)	142.3 (73.1)	138.84 (71.0)	159.0 (81.3)	0.01
History of Medical Illnesses, N (%)				
Hypertension	374 (64.7)	307 (63.8)	67 (69.1)	0.32
Myocardial infarction	39 (6.8)	29 (6.0)	10 (10.3)	0.13
Stroke	44 (7.6)	34 (7.1)	10 (10.3)	0.27
Diabetes	115 (19.9)	88 (18.3)	27 (27.8)	0.032
Angina	32 (5.5)	25 (5.2)	7 (7.2)	0.43
Osteoarthritis	377 (65.2)	297 (61.8)	80 (84.5)	<0.001
COPD	44 (7.6)	27 (5.6)	17 (17.5)	<0.001
Congestive Heart Failure	22 (3.8)	16 (3.3)	6 (6.2)	0.18

Note: All data presented in mean (standard deviation), unless otherwise specified. Continuous variables analyzed by ANOVA; categorical variables analyzed by Pearson chi-square test or Fisher's exact test. *P*-values refer to comparisons between pain intensity levels. PSS: perceived stress scale. Depressive symptoms were evaluated using the 15- item Geriatric Depression Scale. VIQ: verbal IQ. COPD: Chronic Obstructive Pulmonary Disease. WRAT3 is measured by the Wide Range Achievement Test. Free Recall is measured by the Free and Cued Selective Reminding Test. Verbal IQ score is a summary measure drawn from the Wechsler Adult Intelligence Scale - Third Edition.

Table 3

Logistic regression models for pain intensity (no pain/mild pain intensity vs. moderate/severe pain intensity)

	PSS categorized		PSS continuous	
Variables	**OR (95% CI)**	**p-value**	**OR (95% CI)**	***p*-value**
PSS 1st Quartile (scores 0–11)	1 (N/A)	N/A	-	-
PSS 2nd Quartile (scores 12–16)	2.12 (1.06–4.21)	0.033	-	-
PSS 3rd Quartile (scores 17–22)	2.47 (1.24–4.92)	0.010	-	-
PSS 4th Quartile (scores 23–50)	3.24 (1.61–6.52)	0.001	-	-
PSS continuous (per unit)	-	-	1.05 (1.02–1.08)	0.003
Age years	0.96 (0.92–1.00)	0.045	0.96 (0.92–1.00)	0.047
Sex	1.42 (0.85–2.37)	0.18	1.37 (0.82–2.27)	0.23
Race - African American	1.19 (0.67–2.12)	0.56	1.22 (0.69–2.16)	0.50
Race – Other	0.82 (0.29–2.28)	0.71	0.83 (0.30–2.28)	0.72
Alcohol – 2nd tertile	0.92 (0.53–1.61)	0.78	0.96 (0.55–1.67)	0.89
Alcohol – 3rd quartile	0.55 (0.31–1.01)	0.053	0.57 (0.31–1.03)	0.061
Depressive symptoms	1.01 (0.83–1.23)	0.09	1.02 (0.84–1.25)	0.82
VIQ	1.00 (0.98–1.01)	0.70	1.00 (0.98–1.01)	0.64
Hypertension	1.28 (0.78–2.11)	0.33	1.26 (0.77–2.07)	0.37
Diabetes	1.10 (0.63–1.95)	0.73	1.12 (0.64–1.97)	0.70
Osteoarthritis	2.57 (1.53–4.30)	<0.001	2.61 (1.56–4.35)	<0.001
Angina	0.64 (0.23–1.82)	0.41	0.62 (0.22–1.74)	0.37
COPD	1.81 (0.78–4.21)	0.17	1.86 (0.81–4.27)	0.15
Congestive Heart Failure	3.87 (1.20–12.46)	0.023	4.22 (1.32–13.55)	0.015

PSS: perceived stress scale; COPD: Chronic Obstructive Pulmonary Disease

OR of participant characteristics predicting pain intensity in our logistic regression models, (on the left using PSS categorized or on the right PSS continuous) are presented with confidence intervals and p-values. Models include demographic factors and medical history variables with bivariate testing results with pain intensity ≤0.25. Caucasian race and first tertile of alcohol consumption were used for reference groups, respectively.